Strategy Research Project

GLOBAL CLIMATE CHANGE – U.S. ECONOMIC AND NATIONAL SECURITY OPPORTUNITY

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USAWC CLASS OF 2009

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
20-03-2009	Strategy Research Project	

4. TITLE AND SUBTITLE

Global Climate Change – U.S. Economic and National Security Opportunity

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

Colonel Patricia M. Anslow

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

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Center for strategic Leadership

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Army War College
122 Forbes Avenue
Carlisle, PA 17013

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT

Distribution A: Unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

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15. SUBJECT TERMS

Threat Multiplier, Natural Resources, Resource Conflict, U.S. Interests, Energy Policy

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPHONE NUMBER** *(include area code)*
UNCLASSIFED	UNCLASSIFED	UNCLASSIFED	UNLIMITED	32	

USAWC STRATEGY RESEARCH PROJECT

GLOBAL CLIMATE CHANGE - U.S. ECONOMIC AND NATIONAL SECURITY OPPORTUNITY

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This SRP is submitted in partial fulfillment of the requirements of the Master of Strategic Studies Degree. The U.S. Army War College is accredited by the Commission on Higher Education of the Middle States Association of Colleges and Schools, 3624 Market Street, Philadelphia, PA 19104, (215) 662-5606. The Commission on Higher Education is an institutional accrediting agency recognized by the U.S. Secretary of Education and the Council for Higher Education Accreditation.

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ABSTRACT

AUTHOR: Colonel Patricia M. Anslow

TITLE: Global Climate Change – U.S. Economic and National Security Opportunity

FORMAT: Strategy Research Project

DATE: 20 March 2009 WORD COUNT: 6,487 PAGES: 32

KEY TERMS: Threat Multiplier, Natural Resources, Resource Conflict, U.S. Interests, Energy Policy

CLASSIFICATION: Unclassified

The most recent findings of the Intergovernmental Panel on Climate Change (IPCC) state that the current trajectory of greenhouse gas (GHG) emissions will result in significant changes to the world climate and serious implications for the geo-political landscape. These implications create both challenges and opportunities for the United States as they balance national security and economic interests. The effects of climate change could act as a threat multiplier in regions of Asia, Africa, and the Middle East already considered unstable. Conflicts could erupt as weak governments must combat flooding, droughts, and sea level rise and this may require increased U.S. military presence to maintain a stable world order. On the other hand there are various opportunities associated with climate change including opening arctic navigational channels and the vast oil and natural gas resources believed to be underneath the ice, the ability of the United States to provide constrained resources to drought areas, and the increased world demand for clean energy technology. The U.S. climate change policy must include adaption, mitigation, and prevention measures balancing these interests and this paper will explore those possibilities.

GLOBAL CLIMATE CHANGE – U.S. ECONOMIC AND NATIONAL SECURITY OPPORTUNITY

An ounce of prevention is worth a pound of cure.

—Benjamin Franklin

The most recent findings of the Intergovernmental Panel on Climate Change (IPCC) state that the current trajectory of greenhouse gas (GHG) emissions will result in significant changes to the world climate and serious implications for the geo-political landscape.[1] The IPCC summary reports in 2007 have succeeded in propelling international debate and spurring policy makers in the United States to take a harder look at the potential national security concerns of climate change. As the debate continued over the past two years, public opinion and politicians have become increasingly convinced that global warming is occurring and that the effects of it may increase social-economic tensions that could lead to more instability in the world. [2] Recent reports authored by the United States National Intelligence Community (NIC), Center for Strategic International Studies (CSIS) and the Center for Naval Analysis Corporation(CNA), as well as dozens of peer reviewed articles described the effects of global climate change and the potential threat to U.S. security. The military advisory board in the CNA report generated the most concise statement of concern, “Climate change can act as a threat multiplier for instability in some of the most volatile regions of the world, and it presents significant national security challenges for the United States.”[3] The premise is that the direct impacts of climate change, which include flooding, drought, food shortage, and mass migration, will further exacerbate an already weak government’s ability to provide stability in regions such as Sub-Sahara Africa, East Asia, and the Middle East and thus worsen the current security threat.

The potential effects of global climate change paint a grim future for many parts of the world. The fight for scarce resources has been a source of conflict for thousands of years. The first notable conflict occurred 4,500 years ago when residents of the Mesopotamian cities of Lagash and Umma, built canals, diverted water, and aggressively sought to deny water resources and gain an advantage. Peter Gleick's comprehensive list of water wars also chronicles at least 42 violent conflicts across the globe in the past century. Asia and the Middle East with persistent water scarcity concerns recognize that water provides economic power and a high value military target, as evidenced by the ongoing conflicts between India and Pakistan in the disputed Kashmir region and Syria and Israel.[4] Even the United States is not immune to conflicts. Continued droughts in the southeastern United States during the last decade led to legal battles between Georgia, Florida, and Alabama as dwindling water and constant demand pitted states against one another. The conflict threatens to diminish the states' ability to use water for economic interests such as agriculture, navigation, recreation, and industry — everyone has a vested interest.[5]

Paradoxically, however, globalization and technology advancements have also proven that resource management can be a great source for increasing economic interests. A 2006 report by the Woodrow Wilson International Center for Scholars determined that "…instances of cooperation between riparian nations outnumbered conflicts by more than two to one between 1945 and 1999. Why? Because water is so important, nations cannot afford to fight over it."[6] The threat of water scarcity, food shortages, extreme weather events, and resource related migration would cause any government concern, but taking advantage of forewarning and the ability to plan under more stable conditions can provide significant opportunities for cooperation and

adaption. This paper will describe the potential threats posed by climate change predictions, but more importantly will explore global climate change opportunities.

Background

Understanding what drives global climate change is helpful for the development of mitigation or adaption policies. The energy cycle of the Earth is in constant equilibrium as understood by the first law of thermodynamics — energy can neither be created nor destroyed. However, it is constantly transferring as the earth absorbs solar energy and radiates infrared energy into space at an equal rate. Scientists agree that greenhouse gases in the atmosphere are a beneficial natural phenomenon that blankets the earth and provides a sustainable average surface temperature. Without the greenhouse effect, the average surface temperature would be -19^{o}C. The greenhouse gases trap and recycle infrared energy back to earth raising the global mean surface temperature to approximately 15^{o}C.[7]

Many factors contribute to the climate of the earth. Surface temperature alone does not define climate. The energy cycle plays an interactive role with the hydrologic cycle (precipitation, evaporation, and evapotransporation), wind, and cloud cover. The earth's spherical shape, tilt, and its rotation around the sun, all result in the earth receiving varying levels of solar energy to different portions of the earth providing climate variability. Adding to the complexity of the natural model is the positive or negative feedback loops within the system. One example of a positive feedback loop is that warming creates ice melt which releases carbon dioxide and methane from the water vapor. The increased concentration of greenhouse gases in the atmosphere can add to the warming effect.[8] Human factors such as land use contribute to average surface temperatures. The concrete, steel, and asphalt of urban environments create

heat islands that can raise surface temperatures higher than surrounding rural areas. All of these realities make modeling the non-linear interconnected factors producing climate, and predicting climate change, extremely complicated. Thankfully, models are continually improving, particularly in the last decade as the debate about climate change has accelerated.

It is also important to understand that weather and climate are not the same. Historical variations in global average surface temperature throughout the past one million years have corresponded to significant climate variations such as the ice age nearly 100,000 years ago and the Little Ice Age which occurred approximately 1350 to 1850 A.D. Weather variability in itself however, is not an indicator of global climate change. Annual variations occur regularly as part of our natural weather patterns. Thus, a change in weather variability in one portion of the globe does not necessarily correspond to an average global climate change throughout the earth. Analysis of regional weather is however, important for model verification and development. The effects of global climate change on weather patterns will vary by region.

The challenge for scientists is to evaluate if global climate change indicators such as rising surface and ocean temperatures (shown in Figure 1), sea level elevation, ice melt and rising greenhouse gases in the atmosphere are interconnected, and determine if that is natural variability or a sign of significant changes that will accelerate over the next century. They must isolate the factors and determine what is causing our current climate trends. The 2007 IPCC reports with high confidence[9] that the increased anthropogenic greenhouse gases in the atmosphere are driving the observed global climate change. The global atmospheric concentration of carbon dioxide was observed at 379 parts per million (ppm) in 2005, which is a 35% increase from pre-industrial

values of 280 ppm. The natural range over the past 650,000 years as determined from ice cores was 180-300 ppm. Methane follows a similar increase from a pre-industrial value of 715 parts per billion (ppb) and a 2005 reading of 1775 also far exceeding the natural range of 320-790 ppb. Nitrous oxide levels in the atmosphere increased from pre-industrial 279 ppb to 319 ppb in 2005. Fossil fuels are the main contributors of anthropogenic carbon dioxide in the atmosphere and methane and nitrous oxide sources come mainly from agriculture. Interestingly, anthropogenic sources of sulfate, dust, nitrates, organic and black carbon contribute to increased numbers of aerosols in the atmosphere that have a cooling affect. The combined sources however, result in a net warming of the atmosphere.[10]

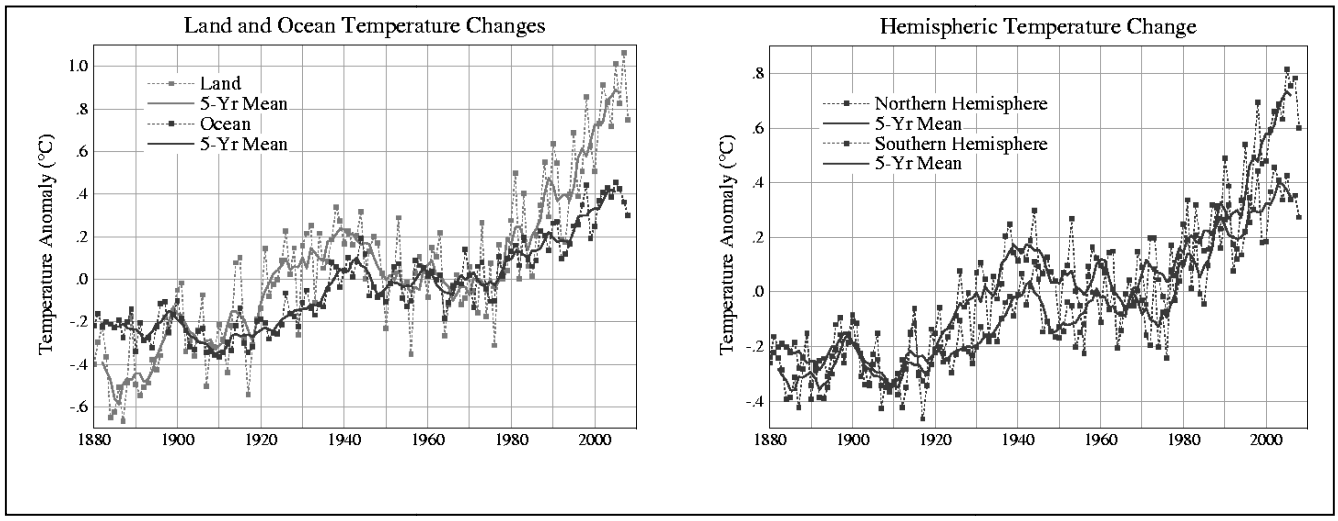

Figure 1. Source: NASA, Goddard Institute for Space Studies, New York, NY http://data.giss.nasa.gov/gistemp/graphs/ Last modified 9 January 2009

For all the momentum and mainstream concurrence with the IPCC findings there remain many skeptics. Critics like Michael Crichton, in his 2004 fictional book State of Fear, warn that alarmist and political manipulation of science can promulgate a false pretense and stifle legitimate debate[11]. Scientist Peter Doran's research in the Antarctic has been a source of great controversy. Both sides of the global warming debate use

his facts to support their point of view. Doran attempted to set the record straight in a New York Times op-ed. He re-iterated that the findings of his co-authored 2002 report were inconclusive on the affects of global warming on Antarctica. The study determined that the Antarctica Peninsula was experiencing warming, and that a small ice-free portion of the mainland had cooled between 1986 and 2000.[12] In December 2008, the United States Senate Environment and Public Works Committee released a minority staff report that sited over 650 international scientists that disagreed with the IPCC man-made global warming claims.[13] Critics argue there is not a consensus of scientists in agreement on anthropogenic induced global climate change as reported by IPCC. The report lists quotes from Nobel Prize winners, geologists, physicists, meteorologists, and climatologists like Stanley B. Goldenberg, a scientist with the U.S. National Oceanic and Atmospheric Administration questioning the validity of man-made global warming, the accuracy of models, and the lack of definitive evidence. The majority of statements did not debate the fact that global climate change is occurring, but recognized that many diverse factors contribute to the effects. Each dissenting scientist provides some important observations and warnings on accepting science without thorough investigation and debate.[14]

Although even critical scientists support the continued modeling and analysis of climate change factors, many also understand that policy makers cannot wait for conclusive evidence before acting. The Senate minority staff report includes the former NASA atmospheric scientist, Dr. JoAnne Simpson, as a critic of the conclusions on man-made global warming. As a scientist, she remains skeptical and is concerned that the argument for anthropogenic increase of greenhouse gas is a product of weak air-surface climate models. She is a proponent for the Tropical Rainfall Measuring Mission

(TRMM) data set and encourages scientists to use it as a 10 year test for trend analysis. However, she does not doubt that greenhouse gases are increasing rapidly and that the resultant warming is having an effect on the environment. Her conclusion, although not duplicated in the Senate report, is that "In this case, we must act on the recommendations of Gore and the IPCC because if we do not reduce emissions of greenhouse gases and the climate models are right, the planet as we know it will in this century become unsustainable."[15]

The debate over the science of global climate change and global warming is extremely beneficial and has added much to the understanding of climate and drivers to climate change over the past several decades. It has resulted in significant improvements to climate modeling, measurements of historical greenhouse gas levels, and accuracy of temperature measurements. The predictive models used for IPCC analysis and assessments continue to improve and can now be validated with actual data. The Fourth Assessment of the IPCC was able to compare the 1990, 1996 and 2001 predictive models for global average temperature with actual readings. Interestingly, the comparison revealed the 1990 model was an over estimate, the 1996 model was an underestimate, but the results of the 2001 models proved to be within the predicted range.[16]

Climate Change Challenges and Opportunities

In the next decade, scientist will further refine climate models and continue to clarify the interaction between energy, water, the earth, and man. National security professionals must also determine if the available data on the subject of global warming is creditable enough to develop mitigation policies and contingency planning for its possible effects. The military advisory board in the CNA report on *National Security and*

the Threat of Climate Change recommended, “As military leaders we know we cannot wait for certainty. Failing to act because a warning isn’t precise enough is unacceptable.”[17] Waiting until the data is definitive presents great risk to the U.S. national security as affects of climate change including droughts, tsunamis, and flooding force mass migrations in Asia, Africa, and the Middle East. The potential for instability from climate change could result in increased U.S. military presence in those regions, increased humanitarian relief, and sea level rise that may cause loss of critical military bases located along coastlines throughout the world. However, taking prudent measures that mitigate or provide potential adaption to climate change, while also increasing U.S. economic interests is worthwhile.

The best prescription for addressing global climate change is to mitigate factors humans can control and adapt to circumstances out of our control. The method for dealing with uncertainty is often to determine a probability and assess the severity of the possible outcomes. This assessment of a threat provides a risk value. An event that has a low probability and low consequences is the lowest risk, where as a high probability and high consequence event has the highest risks. In military planning it is common practice to also develop contingency plans for any high consequence event regardless of the probability. Developing strategies against this type of low probability and high consequence event is also a common approach to assessing and preparing for natural disasters such as flooding and hurricanes. The National Flood Insurance Program (NFIP) requires home mortgage owners to have insurance if they live in an area that has a high risk of flooding. High risk homes are those calculated to have a 1% chance of flooding on an annual basis, or a 26% chance of flooding over the life of a 30 year mortgage.[18] The decision to provide maps of susceptible areas and encourage

avoidance through the NFIP has proven to be a cost and life saving measure to combat a natural hazard compounded by man's choice of where to build property. The science of predicting a flood location and intensity is far more certain than climate change, but the analysis provided by the 2007 IPCC assessment and more refined local models make it is possible to do the same type of risk analysis for high risk climate change areas.

The 2007 IPCC Fourth Assessment Report provides some clarifying terminology to help guide the reader in the confidence of the analysis of the findings and likelihood of predicted outcomes (see footnote 9). This assists in the determining the probability of outcomes and the level of risk. The relative increase in atmospheric greenhouse gases drives the projected outcome scenarios in the IPCC findings. The rise in the average surface temperature will be proportional to the amount of greenhouse gases in the atmosphere which will then dictate glacier melt and sea level rise. The assumption is that a reduction in greenhouse gas emissions will reduce the severity of global climate change.

In the most modest emissions scenario, the IPCC predicts the best estimate for temperature increase within the next century is 1.8^{o}C and a sea level rise between 0.18-0.38 meters.[19] The physical and biological consequences of this global climate change will paint a bleak picture for many regions of the world, particularly Africa and Asia. The findings included a very likely increase in frequency of hot extremes, heat waves, and heavy precipitation in high latitudes. There is a likely increase in tropical cyclone intensity and a decrease in precipitation in most subtropical land regions. And there is high confidence that by mid-century water availability and runoff will increase in high latitudes while it will decrease in some dry regions in the mid-latitudes, tropics, and

semi-arid areas to include Mediterranean Basin, western United States, southern African and north eastern Brazil.[20]

Several Washington, DC think tanks have analyzed the national security implications of this likely scenario and some scenarios with even lower probability but more severe consequences. The Center for a New American Security and Center for Strategic & International Studies developed a report called "The Age of Consequences: The Foreign Policy and National Security Implications of Global Climate Change." The report describes the likely operating environment for the 21st Century. The areas of greatest concern are climate change impacts in South Asia, Nigeria, and East Africa where weak and failing states are least able to adapt to the potential consequences. As an example, Nigeria will suffer from drought, desertification, and food production decline. Socio-economic tension in the most populous country on the continent could lead to increased regional tension or migration to resource rich areas of Europe. This could exasperate Europe's existing ethnic and religious tensions.[21] The United States has significant foreign and economic interest in Nigeria. It is the fifth largest supplier of crude oil to the United States at 1 million barrels of oil a day in 2008.[22] Climate change consequences could require United States military and humanitarian intervention on a much greater basis in the 21st century.

The potential opportunity to proactively address climate change in this region with tied economic interests is through education and infrastructure improvements. The newly established Africa Command (AFRICOM), the State Department, and the United States Agency for International Development (USAID) have an opportunity to facilitate African governments in an assessment and evaluation of their climate change risk. The U.S. could provide technical assistance for mapping coastal areas threatened by

projected sea level rise, and assist with the design and construction of water supply and irrigation conservation projects to help alleviate the potential stress of droughts and reduce impacts to food production. The United States could also support clean energy projects in these developing countries that would count as carbon credits through the Clean Development Mechanism (CDM).[23] At a minimum contingency plans at AFRICOM should consider worse case events of resource conflicts and natural disaster response.

The consequences of global climate change for North American resources to include extreme weather events could directly affect U.S. economic and national security interests. A recent assessment by the U.S. Climate Change Science Program noted that severe weather in the United States is on the rise. The assessment concluded that during the period 1980-2006 the US had 70 natural disasters that each exceeded $1 billion in damages.[24] The IPCC predicts the United States has a 60-90% probability of an increase in extreme events over the next century. This includes more intense precipitation, more droughts and wild fires in the west, more intense north Atlantic hurricanes, and generally less cold days and nights while there are more frequent hot days and nights.[25] This continued and perhaps increasing trend is a significant concern for the U.S. economy.

Extreme weather events in the United States have often required defense support to civil authorities when local resources are overwhelmed. The response to the 2005 Hurricane Katrina resulted in the deployment of over 17,000 active duty personnel, 50,000 National Guard soldiers from all 50 states, 20 ships, 360 helicopters, and more than 90 fixed wing aircraft all within a week of the hurricane hitting land.[26] Although this is a core capability of U.S. military forces, increased responses of this magnitude reduce the ability of the military to perform their roles in major combat operations.

Expanding the force size and equipment in an attempt to combat increased extreme weather events is very expensive. Unfortunately, the military is lacking the necessary analysis to define military force and equipment needs for balancing these mission requirements. The U.S. Government Accountability Office (GAO) in its April 2008 report on Homeland Security noted that the multiple Federal agencies responsible for comprehensive planning have not defined the National Guard requirements for providing civil support.[27]

The National Guard is often the Department of Defense first responders to local, state, and Federal agencies during disasters. Since September 11, 2001 the National Guard has become an operational force providing tens of thousands of personnel annually in the Global War on Terror. The GAO report claimed that the increasing deployments of the National Guard decreased its ability to perform its dual role as support to civil authority.[28] A comprehensive analysis of the dual role requirements of the National Guard in conjunction with projected climate change impacts should be part of the upcoming Quadrennial Defense Review. This would afford planners and resource providers an opportunity to project requirements and adequately equip the force or make plans for alternate support to civil authorities. This analysis will only be effective if conducted in conjunction with Department of Homeland Security (DHS) planning assumptions and constraints.

Water resources in the United States have been an integral part of the nation's national security and economic interests since the founding of the country. In the jointly published "A Cooperative Strategy for the 21st Century" the U.S. Navy, Marines, and Coast Guard recognize the commercial and military importance of the world's waterways. The report highlights three interactive concepts of importance: first, that

90% of world's commerce travels by sea; second, a vast majority of the world's population lives within one hundred miles of a coastline; and last, that global climate change impacts on the world's water resources could destabilize nations through resource competition and natural disasters, but also create economic opportunities.[29] According to the U.S. Army Corps of Engineers the inland waterways of the United States carry over 630 million tons of cargo valued at more than $70 billion annually, and the replacement value for the navigation system is over $125 billion in 1997 dollars. [30] Effects of climate change in the U.S. include sea level rise along coastal waters and ports, decreasing water in the navigation channels from droughts in the southeast, as well as, increased flooding in the northwestern and upper Mississippi from snow melt.[31] These factors could disrupt the operations of the U.S. waterways as currently designed. Preparing for the uncertainty of global climate change is critical for ensuring that U.S. national security and economic interests are minimally impacted.

In August 2007, Russia staked a claim to the resources below the Arctic by placing a titanium flag at the North Pole. Immediately Canada, United States, Denmark, Finland, Norway and others questioned Russia's motives and denounced its legitimacy for claiming rights. James Overland, an oceanographer at the National Oceanic and Atmospheric Administration (NOAA) has reported that the shrinking ice cover in the Arctic is making more of the sea available for navigation and resource exploration. He reported that the Northwest Passage provided an open sea lane from Europe to Asia during late summer in 2007. Adding to the rising foreign and economic tensions is the disadvantage facing the United States with only two working ice breakers in the region while Russia has 18 and Canada is spending billions to patrol the waters.[32]

The United States also has a great opportunity for economic gain in the Arctic. The United States Geological Survey (USGS) estimates that the arctic may contain 90 billion barrels of oil reserves and 1,670 trillion cubic feet of natural gas.[33] The United States could be standing on the side lines if they do not ratify the Law of the Sea Treaty. Peaceful settlement of resource rights concerns in the region may require United Nation's support. Since the United States is not a ratifying member, but the other seven arctic nations with direct interests are, this could exasperate our security and economic interests. The U.S. Navy and Coast Guard in cooperation with the U.S. Department of Commerce should complete a deliberate analysis of navigation and equipment requirements. The analysis should compare the cost of additional ice breakers against the economic gain of oil reserves and natural gas. Additionally, the 2004 multinational/multiagency Arctic Marine Transport Workshop identified several targeted research and analysis recommendations to better understand the changing environment and potential economic investment opportunities.[34] The U.S. Department of Commerce should facilitate completion of the analysis to determine the economic value of navigation options through the Arctic passage ways.

The United States Federal agencies responsible for regulating and monitoring our water management concerns have recently come together to develop guidance on the assessment of global climate change in long-term planning. In December 2008, the U.S. Geological Survey, in cooperation with the U.S. Army Corps of Engineers, U.S. Department of Interior, Bureau of Reclamation, and the National Oceanic and Atmospheric Administration published the draft report "Climate Change and Water Resources: A Federal Perspective." The document recognizes the uncertainty of global climate change data and the importance of planners to include potential affects in future

water resource management scenarios. Planning assumptions are not a new concept for water resource managers as demand, economics, and other planning factors are not an exact science. The document provides a helpful framework for including the potential effects of climate change with other operational uncertainties for a more accurate plan. The other useful guidance is the inclusion of adaptive management in future water resource projects. This will build flexibility into projects that have significant economic interest to the nation.[35]

Having clean and reliable water sources for domestic and commercial uses in the U.S. ensures a high quality of life and economic sustainability. Access to water has provided an economic advantage to the U.S. agriculture, energy, and manufacturing industries for centuries. Climate change could alter average water temperatures and reduce reliability of available water sources. Understanding these potential factors is important for maintaining sustainable water systems and not creating costly and unnecessary compliance measures for industry. The United States Environmental Protection Agency (EPA) charged with regulating the United States water quality parameters released the National Water Program Strategy, Response to Climate Change in September 2008. The plan outlined five strategic goals related to the EPA's mission of maintaining water quality in the United States.[36]

The recently developed guidance and goals accounting for climate change in our Federal water resource programs are significant steps toward adapting to risks that affect the US national security and economic interests. Considering climate change affects in any future program is a wise measure of assessing low probability, high consequence events and potentially averting significant damages with minimum effort. This is excellent progress in managing affects and proactively minimizing potential

damages. The next step in this process is to develop zoning maps with probabilities of risk associated with coastal areas to aid private citizens, land developers, states and local governments in the management of at risk areas.

The challenges and opportunities discussed above address a broad definition of the problem and several adaptive measures that have little upfront cost with significant long-term savings, regardless of what may be triggering climate change. There are also a variety of approaches possible to mitigate greenhouse gas emissions and reduce the perceived causes of manmade climate change

Potential Policy Solutions

The U.S. failure to ratify the Kyoto Protocol in 2005 degraded the country's diplomatic status and ability to leverage its' economic powers since its consumption of 25% of the world's fossil fuel makes it a major contributor to GHG emissions. The requirement for U.S. industries to comply with reductions when the clean energy technology is unproven and expensive puts those companies at an economic disadvantage over companies in developing countries that are not required to abide to the same standards. In contrast, the increasing demand for clean energy technologies presents U.S. companies with that expertise a great opportunity to advance in the global market. The world needs economic incentives to maintain the momentum to drive change. A green revolution could provide much needed economic growth during this global recession. If the reduction in GHG halts or reverts the current climate change trend, it will also prevent devastating shortages of food and water, promote peace, and potentially reduce expensive responses to world-wide natural disasters.

Stay the Current Course – Self Regulation. The U.S. policy on global climate change under the Bush administration recognized the need to reduce greenhouse gas

(GHG) emissions and identify cleaner and more efficient energy technology. In early 2002, President Bush established goals to reduce America's GHG emissions intensity by 18% through 2012. "Emissions intensity" is the ratio of carbon emissions to economic output, which for the United States is Gross Domestic Product (GDP).[37] In April 2008, President Bush announced a more aggressive national goal to stop the growth of United States greenhouse gas emissions by 2025.[38] The question remains whether this self-regulatory policy, is enough to reduce the potential catastrophic affects of global climate change while maintaining the national economic interests. The Bush administration was concerned that the 7% reduction requirements for the United States in the Kyoto Protocol would adversely affect the vast industries that contribute to carbon emissions such as energy, automotive, forestry, and agriculture.

Voluntary programs and partnerships is the current method to meet the existing goal of 18% reduction in emission intensity from the period 2002 to 2012 and reach the goal of stopping growth of GHG emission by 2025. The current approach would result in reduction of emissions from 181 metric tons per one million dollars of GDP to 151 metric tons by 2012. This could mean 100 million metric tons less emission in 2012 alone and a cumulative reduction of 500 million metric tons since 2002. The voluntary public-private partnership represented by Climate VISION represents approximately 40-45 percent of the business sectors responsible for carbon emission in the United States. The working group shares data, technology, and seeks ways to develop innovative solutions to meet the existing goals.[39] The United States provides data for the Kyoto Protocol, but all reporting of successful GHG emissions reduction technology and techniques by industry is still voluntary as established by Section 1605(b) of the Energy Policy Act of 1992.[40]

The existing policy that promotes voluntary reporting and private-public partnerships to develop clean energy technology will feasibly meet the national interest of economic growth while slowing, but not stopping or reversing emissions. Under this process, economics, mainly the cost of fossil fuel, will drive scientific progress in the development of clean energy technologies. This policy does not impose stringent regulatory requirements on the U.S. economy resulting in immediate cost increases until reliable and cost efficient energy alternatives are available. The 2007 Climate Action Change Report projects that this policy will lead to an 18.6% reduction in emission intensity, but no reduction of the overall emissions of GHG over the 10-year time period. The policy may meet former President Bush's goals, but falls far short of the international goals.

The United States Climate Change Technology Program, the multi-agency planning and coordination group chartered to evaluate climate change information and facilitate technology transfer, has published several reports in the past year concurring with the findings of the Intergovernmental Panel on Climate Change (IPCC). The findings include the need for more drastic reductions in GHG in the atmosphere, not just slowing down emissions.[41] The risk of continuing the policy of voluntary compliance is the realization of the geo-political impacts of climate change. Those potential realities — increasing conflicts abroad, disputes over arctic navigation corridors and resources, and sea level rise causing more frequent and severe natural disasters at significant expense to the United States — are not in the Nation's security and economic interests.

Move forward on Kyoto Protocol. Another policy option is to ratify the Kyoto Protocol and agree to mandatory reductions of GHG emission by 2030, surpassing the current United States policy goals, and adoption of the three market based mechanisms

for regulating and reducing emissions in the United States and globally. The three mechanisms are emissions trading, clean development mechanism (CDM), and joint implementation (JI).[42] The mechanisms serve as opportunities for countries reducing their GHG emissions to work with countries that have excess emissions. Under the first mechanism a country could purchase emission credits from a country which is under their emission threshold. Credits are sold on the open market and give an economic incentive to countries meeting and exceeding their reduction limits. The CDM allows a developed country to receive reduction credit for sponsoring an emission reduction project in a developing country. The benefit is that the global reduction is closer to realization and clean energy technology is brought to parts of the world that might not otherwise be able to afford it. The third mechanism of the protocol is JI and this allows two developed countries to partner on emission reduction projects also expanding emission reduction technology.

Currently, 183 countries have ratified the Kyoto Protocol accounting for 63.7% of the global target emission reductions.[43] The U.S. reduction goal of 7% (using 1990 base calculations of six greenhouse gases), represents most of the remaining target. The initial cost of developing clean energy technology is expensive; however, the first corporations to develop reduction emissions technology can market that product to all the industrial and developing countries. Calculations of the potential economic impacts of compliance vary. In 1998, the Department of Energy estimated a potential 4.2% loss of GDP — the most extreme of the studies. [44] However, recent analysis by McKinsey and Company suggests that the United States could reduce emissions by 30% by 2030, more than four times the U.S. goal, with no costs simply by realizing the full cost-savings of energy efficiency and innovation.[45] Increasing fuel costs over the summer of

2008 were a tremendous economic incentive for developing alternative clean fuel automotive and industrial options. The recent global recession and falling fuel prices complicate the ability to conduct cost to benefit analysis.

Implementation of the Kyoto Protocol's 7% reduction goal is certainly a more suitable course of action for reducing global greenhouse gases than the current voluntary compliance policy. This will lessen the potential long-term national security risks of climate change, however based on current economic fluctuations it is difficult to predict the actual costs of mandatory versus voluntary implementation over the long run. Most of the major U.S. economic allies and competitors accepted this option. Former Secretary of Treasury Paulson recognized that not signing the Kyoto Protocol was a competitive disadvantage for the United States in the global economy. The greatest risk of signing the Protocol is the competitive advantage obtained by developing countries such as China and India.[46] China has recently exceeded the United States in total CO_2 emissions — but not on a per capita.[47] The tremendous contribution of greenhouse gases by developing countries if left unchecked could surpass any potential benefits of reduction by the industrial nations. The ability for China and India to develop without restrictions may be an economic risk too great for the United States.

Propose Significant Changes to Kyoto Protocol- Promoting a Global Green Revolution. A third option for policy on climate change is for the U.S to take the leadership role in promoting amendments to the Kyoto Protocol that would mandate reductions by all contributors to GHG emissions. The Kyoto Protocol deliberately addressed equity by establishing larger reduction targets on the industrial countries who have contributed to the problem for the past 150 years. The unfortunate secondary

effect is that the economic advantage to the newest contributors to the problem is also a disincentive to finding and adapting reduction measures. Based on IPCC predictions China, East Africa, and many Asian coastal nations are poised for the greatest adverse impacts of climate change.[48]The exponentially rising GHG emissions of nations like China and the dependence of agriculture on developing countries in Africa could result in no net gain in reductions, if they are not included in the international agreement to reduce global warming. A suitable option to reduce the atmosphere's greenhouse gases must include all nations contributing to the problem. This is particularly true for those nations that have the greatest potential impacts and are least adaptable to climate change. The Protocol should require an immediate succession of growth in emissions for developing nations. Further reduction requirements should coincide with the development of affordable reduction technology.

The Kyoto Protocol market based mechanisms for GHG emissions reductions are in need of reforms to be effective economic drivers. Analysis of the recent cap and trade emissions initiatives in the European Union (EU) determined that erroneous baseline conditions drove the trade price to nearly zero making the mechanism ineffective.[49] The Clean Development Mechanism (CDM) has not proven to be an incentive for reducing emissions. Analysis of projects given CDM credit over the past four years has shown no reduction in GHG emissions. China has more than 700 hydroelectric plants proposed for CDM approval and are adding nearly 25 per month. Although these have a lower carbon footprint than a coal burning electric power plant, these hydroelectric power plants were already part of the Chinese expansion plans and do nothing to reduce the ever increasing energy demand in the country.[50] The amended Protocol should improve monitoring of cap and trade pricing and limit CDM projects to

legitimate reduction projections. These changes would provide an economically acceptable and feasible option for the United States.

Regardless of changes to the protocol, the United States must provide significant tax incentives, as well as, research and development funding to foster emerging clean energy technologies until they become affordable on the open market. By taking the global economic and technological lead, the U.S. policy will greatly enhance the nation's economic interest, reduce dependence on foreign energy sources, and increase national security. The risk to this option is that U.S. competitors may develop the technology first. However, competition has always been an advantage to the United States, and the alternative affects of global climate change are not acceptable.

Recommendations

U.S. policies for global climate change should ensure we are including the risk assessment of climate change in our military strategy, national security planning, Federal planning, and local development planning. Although the net probability of affects may be low, the consequence can be very high. The current course of voluntary self regulation or even adopting the Kyoto Protocol as currently written will not lead to reduction in GHG. The only chance to significantly reduce GHG is new international goals that include the developing countries and revisions to the Kyoto Protocol mechanisms. There will be economic costs to compliance with GHG reduction goals, but including developing economies in that process will ensure economic equity and actually achieve the required reduction. Seeking low cost adaptive and mitigation measures within the U.S. domestic policies will also reduce the potential effects of climate change.

The best defense is education, avoidance, prudent adaption measures, and dual-purpose mitigation. The U.S. should take every opportunity to develop clean energy technologies that will have a direct and immediate impact on our economic interests and over the long-term facilitate an environmentally stable 21st century that will protect our national security interests. A green revolution has been budding in the U.S. since the wave of environmental laws in the early 1970's. The U.S. economy has not suffered during the process of developing sustainment of our natural resources. The next stage of the revolution should include clean energy and that has the potential to help push the U.S. out of the current global economic downturn. The Council on Foreign Relations published a report in late 2007 detailing many of the national security concerns from the affects of global climate that are mentioned in this paper. In the report, Joshua Busby succinctly concluded, "Climate policy should seek to avoid the worst consequences of global warming. It should start with no-regrets measures that make sense even if the consequences of climate change prove less than severe."[51]

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Clarifying Definitions				
Degree of Confidence in being correct			**Likelihood of the Occurrence Outcome**	
Very High Confidence	At least 9 out of 10 Chance		Virtually Certain	>99% probability
High Confidence	About 8 out of 10 chance		Very Likely	90 to 99% probability
Medium Confidence	About 5 out of 10 chance		Likely	66 to 90% probability
Low Confidence	About 2 out of 10 chance		About as likely as not	33 to 66% probability
Very Low Confidence	Less than 1 out of 10 chance		Unlikely	10 to 33% probability
			Very Unlikely	1 to 10% probability
			Exceptionally Unlikely	< 1% probability

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